

Claims

1. A method of controlling or inhibiting an insect which comprises contacting said insect with effective amounts of a Protein A, a Protein B, and a Protein C, wherein:
 - (i) each of said Proteins A, B, and C is encoded by a naturally occurring gene or has an amino acid sequence that differs from the product encoded by a naturally occurring gene only by truncation or by conservative amino acid changes;
 - (ii) said Protein A is a 230-290 kDa toxin complex insect toxin that is derived from a first taxonomic species, has stand alone insecticidal activity, and has an amino acid sequence at least 40% identical to a sequence selected from the group consisting of SEQ ID NO:14 (XptA1Xwi), SEQ ID NO:34 (XptA2 Xwi), SEQ ID NO:21 (TcdA), SEQ ID NO:62 (TcdA2), SEQ ID NO:63 (TcdA4), and SEQ ID NO:59 (TcbA);
 - (iii) said Protein B is a 130-180 kDa toxin complex potentiator having an amino acid sequence at least 40% identical to a sequence selected from the group consisting of SEQ ID NO:22 (TcdB1), SEQ ID NO:45 (TcdB2), SEQ ID NO:56 (TcaC), SEQ ID NO:18 (XptC1_{Xwi}), SEQ ID NO:49 (XptB1_{Xb}), SEQ ID NO: 40 (PptB1(orf5)), and SEQ ID NO:60 (SepB);
 - (iv) said Protein C is a 90-120 kDa toxin complex potentiator having an amino acid sequence at least 35% identical to a sequence selected from the group consisting of SEQ ID NO:25 (TccC1), SEQ ID NO:58 (TccC2), SEQ ID NO:47 (TccC3), SEQ ID NO:64 (TccC4), SEQ ID NO:57(TccC5), SEQ ID NO:16 (XptB1_{Xwi}), SEQ ID NO:51 (XptC1_{Xb}), SEQ ID NO:43 (PptC1 (orf 6 long)), SEQ ID NO:42 (PptC1 (orf 6 short)), and SEQ ID NO:61 (SepC);
 - (v) at least one of said Protein B and said Protein C is derived from a second taxonomic species that is different from said first taxonomic species;
 - (vi) if said Protein B is derived from said second taxonomic species, then the amino acid sequence of said Protein B is less than 75% identical to the amino acid sequence of any protein known to be produced by said first taxonomic species; and

- (vii) if said Protein C is derived from said second taxonomic species, then the amino acid sequence of said Protein C is less than 75% identical to the amino acid sequence of any protein known to be produced by said first taxonomic species;

wherein a given protein is considered to be derived from a particular species if either the genome of that species contains a gene that encodes the protein or the given protein was designed by truncating or making conservative amino acid changes in the amino acid sequence of a protein encoded by a gene contained in the genome of that species.

2. The method of claim 1 wherein said first and second taxonomic species are from different genera.
3. The method of claim 2 wherein said Protein A is derived from a *Photorhabdus* species and at least one of said Protein B and Protein C is derived from a *Xenorhabdus*, *Paenibacillus*, *Serratia* or *Pseudomonas* species.
4. The method of claim 2 wherein said Protein A is derived from a *Xenorhabdus* species and at least one of said Protein B and Protein C is derived from a *Photorhabdus*, *Paenibacillus*, *Serratia* or *Pseudomonas* species.
5. The method of claim 2 wherein at least one of said Protein A, Protein B, and Protein C is derived from a *Xenorhabdus* species and at least one of said Protein A, Protein B, and Protein C is derived from a *Photorhabdus* species.
6. The method of claim 2 wherein at least one of said Protein A, Protein B, and Protein C is derived from a *Photorhabdus* species and at least one of said Protein A, Protein B, and Protein C is derived from a *Xenorhabdus* species.
7. The method of claim 1 wherein:
 - (i) Protein A is SEQ ID NO: 34(XptA2_{Xwi}) or SEQ ID NO:21 (TcdA),

- (ii) Protein B is SEQ ID NO:45 (TcdB2), SEQ ID NO:40 (PptB1₁₅₂₉), or SEQ ID NO:49 (XptB1_{x_b}), and
- (iii) Protein C is SEQ ID NO:47 (TccC3), SEQ ID NO:42 (PptC1₁₅₂₉-short), SEQ ID NO:43 (PptC1₁₅₂₉-long), or SEQ ID NO:51 (XptC1_{x_b}).

8. The method of claim 5 wherein said Protein A has at least 40% identity with a protein selected from the group consisting of SEQ ID NO:14 (XptA1_{x_{wi}}) and SEQ ID NO:34 (XptA2_{x_{wi}}).

9. The method of claim 6 wherein said Protein A has at least 40% identity with a protein selected from the group consisting of SEQ ID NO:21 (TcdA) and SEQ ID NO:59 (TcbA).

10. The method of claim 8 wherein Protein B has at least 40% identity with an amino acid sequence selected from the group consisting of SEQ ID NO:22, SEQ ID NO:40, SEQ ID NO:45, and SEQ ID NO:49, or Protein C has at least 35% identity with an amino acid sequence selected from the group consisting of SEQ ID NO:25, SEQ ID NO:42, SEQ ID NO:47, and SEQ ID NO:51.

11. The method of claim 9 wherein Protein B has at least 40% identity with an amino acid sequence selected from the group consisting of SEQ ID NO:18 and SEQ ID NO:40; or Protein C has at least 35% identity with an amino acid sequence selected from the group consisting of SEQ ID NO:16 (XptB1_{wi}) and SEQ ID NO:42.

12. The method of claim 5 wherein said Protein A is encoded by a polynucleotide that hybridizes under stringent conditions with a probe that is the full complement of a nucleic acid sequence that encodes an amino acid sequence selected from the group consisting of SEQ ID NO:14 (XptA1_{wi}) and SEQ ID NO:20 (XptA2_{wi}).

13. The method of claim 6 wherein said Protein A is encoded by a polynucleotide that hybridizes under stringent conditions with a probe that is the full complement of a nucleic acid sequence that encodes the amino acid sequence shown in SEQ ID NO:21 (TcdA).

14. The method of claim 8 wherein Protein B is encoded by a polynucleotide that hybridizes under stringent conditions with a probe that is the full complement of a nucleic acid sequence that encodes an amino acid sequence selected from the group consisting of SEQ ID NO:22, SEQ ID NO:40, SEQ ID NO:45, and SEQ ID NO:49, or said Protein C is encoded by a polynucleotide that hybridizes under stringent conditions with a probe that is the full complement of a nucleic acid sequence that encodes an amino acid sequence selected from the group consisting of SEQ ID NO:25, SEQ ID NO:42, SEQ ID NO:47, and SEQ ID NO:51.

15. The method of claim 9 wherein said Protein B is encoded by a polynucleotide that hybridizes under stringent conditions with a probe that is the full complement of a nucleic acid sequence that encodes an amino acid sequence selected from the group consisting of SEQ ID NO:18 and SEQ ID NO:40, or said Protein C is encoded by a polynucleotide that hybridizes under stringent conditions with a probe that is the full complement of a nucleic acid sequence that encodes an amino acid sequence selected from the group consisting of SEQ ID NO:16 (XptB1_{wi}), and SEQ ID NO:42.

16. A transgenic plant or plant cell that produces a Protein A, a Protein B, and a Protein C, wherein

- (i) each of said Proteins A, B, and C is encoded by a naturally occurring gene or has an amino acid sequence that differs from the product encoded by a naturally occurring gene only by truncation or by conservative amino acid changes;
- (ii) said Protein A is a 230-290 kDa toxin complex insect toxin that is derived from a first taxonomic species, has stand alone insecticidal activity, and has an amino acid sequence at least 40% identical to a sequence selected from the group consisting of SEQ ID NO:14 (XptA1_{xwi}), SEQ ID NO:34 (XptA2_{xwi}), SEQ ID NO:21 (TcdA), SEQ ID NO:62 (TcdA2), SEQ ID NO:63 (TcdA4), and SEQ ID NO:59 (TcbA);
- (iii) said Protein B is a 130-180 kDa toxin complex potentiator having an amino acid sequence at least 40% identical to a sequence selected from the group consisting of SEQ ID NO:22 (TcdB1), SEQ ID NO:45 (TcdB2), SEQ ID NO:56 (TcaC), SEQ ID NO:18

(XptC1_{Xwi}), SEQ ID NO:49 (XptB1_{Xb}), SEQ ID NO:40 (PptB1(orf5)), and SEQ ID NO:60 (SepB);

(iv) said Protein C is a 90-120 kDa toxin complex potentiator having an amino acid sequence at least 35% identical to a sequence selected from the group consisting of SEQ ID NO:25 (TccC1), SEQ ID NO:58 (TccC2), SEQ ID NO:47 (TccC3), SEQ ID NO:64 (TccC4), SEQ ID NO:57 (TccC5), SEQ ID NO:16 (XptB1_{Xwi}), SEQ ID NO:51 (XptC1_{Xb}), SEQ ID NO:43 (PptC1 (orf 6 long)), SEQ ID NO:42 (PptC1 (orf 6 short)), and SEQ ID NO:61 (SepC);

(v) at least one of said Protein B and said Protein C is derived from a second taxonomic species that is different from said first taxonomic species;

(vi) if said Protein B is derived from said second taxonomic species, then the amino acid sequence of said Protein B is less than 75% identical to the amino acid sequence of any protein known to be produced by said first taxonomic species;

(vii) if said Protein C is derived from said second taxonomic species, then the amino acid sequence of said Protein C is less than 75% identical to the amino acid sequence of any protein known to be produced by said first taxonomic species;

wherein a given protein is considered to be derived from a particular species if either the genome of that species contains a gene that encodes the protein or the given protein was designed by truncating or making conservative amino acid changes in the amino acid sequence of a protein encoded by a gene contained in the genome of that species.

17. A transgenic plant or plant cell of claim 16 wherein:

(i) Protein A is SEQ ID NO:34 (XptA2_{Xwi}) or SEQ ID NO:21 (TcdA),

(ii) Protein B is SEQ ID NO:45 (TcdB2), SEQ ID NO:40 (PptB1₁₅₂₉), or SEQ ID NO:49 (XptB1_{Xb}), and

(iii) Protein C is SEQ ID NO:47 (TccC3), SEQ ID NO:42 (PptC1_{1529-short}), SEQ ID NO:43 (PptC1_{1529-long}), or SEQ ID NO:51 (XptC1_{Xb}).

18. A method of claim 1 wherein said insect is brought into contact with a second Protein A that is derived from a taxonomic species different from said first taxonomic species.

19. A method of claim 18 wherein said insect is brought into contact with a first Protein A selected from SEQ ID NO:14 (XptA1_{Xwi}) and SEQ ID NO:34 (XptA2_{Xwi}) and a second Protein A selected from SEQ ID NO:21 (TcdA) and SEQ ID NO:59 (TcbA).

20. A method of claim 18 wherein said first Protein A is SEQ ID NO:14 (XptA1_{Xwi}), said second protein A is SEQ ID NO:21 (TcdA), said protein B is SEQ ID NO:45 (TcdB2) and said protein C is SEQ ID NO: 47 (TccC3).